

**EXPRESS MAIL LABEL NO. EL746147253US**

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5       **SYSTEM AND METHOD FOR ELIMINATING DUPLICATE COPIES OF ACTIVITY  
HISTORY LOGS IN BRIDGING TWO OR MORE BACKEND DATABASE SYSTEMS**

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**CROSS REFERENCE TO RELATED APPLICATIONS**

Not Applicable

20       **BACKGROUND OF THE INVENTION**

**FIELD OF THE INVENTION**

This invention generally relates to the field of database management, and  
more particularly to a system and method for the efficient control of updates between  
multiple copies of a database.

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**DESCRIPTION OF THE RELATED ART**

Databases and database management are widely used in businesses today.  
Database software organizes collections of data so that its contents can easily be  
accessed, managed, and updated. One widely used type of database is the

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relational database. This is a tabular database in which data is defined so that it can be reorganized and accessed in a number of different ways. With networked computers and in particular the Internet there is high usage of distributed databases. The databases are dispersed or replicated among different points in a network, allowing simultaneous access from "local" points of presence, which can span different time zones. The local access allows for fast information exchange without a single point in the network becoming a bottleneck. Additionally, the multiple copies of a database provide data backup for disaster recovery. Although these distributed database solutions are useful, they never the less have several challenges and some shortcomings.

One challenge is that the data in distributed databases changes during usage at the different points of presence in the network. These changes must be communicated to the other database systems to ensure the data timeliness and integrity. An example of a distributed database application is a distributed problem management system. Continuing further, suppose an end user has been helped with a notebook problem through a help desk management system at a first geographic location. Later the same end user while traveling requires further assistance regarding the same notebook problem. It is desirable for the help desk management system at a second location to be able access the activity located at the first geographic location. The challenge in this example is that if the distributed databases are not keep synchronized the end user asking for help will be asked to re-explain the history of the problem each time a call is made. Additionally, the help desk operator will not have the benefit of knowing what was tried or suggested in the past. Accordingly, a need exists for a bridging method and system to keep multiple copies of help desk database information accurate as changes are being made to different copies of the data at different database locations.

Another challenge with prior art distributed help desk solutions is the synchronization of problems between two or more companies. For example, with a

printer problem, an end user may contact the printer company's help desk. After being directed to try several fixes to the problem it may turn out that the problem may not be with the printer hardware but rather with the printer software. When the end user contacts the software company the user typically must explain the entire problem again. Accordingly, a need exists for a bridging application to enable cooperation between collaborative companies and their databases so as to better server their customers.

Another shortcoming to the distributed databases being at different companies is that the databases may be designed using different database schemas. In fact the databases may not even be from the same provider e.g. IBM DB/2 versus Oracle. Accordingly, a need exists for a bridging application that can work with different database products using different database schemas.

Another shortcoming to the distributed databases being at different companies is that the databases may contain additional relevant information for a given record. This information may be considered sensitive or even confidential. Accordingly, a need exists for a bridging application to be able to exchange parts of databases between different companies without exposing sensitive or confidential entries.

One solution known in the prior art for overcoming the shortcomings is the use of time stamps for managing updates between databases.

TIME STAMP TAG FOR RECORD CONTROL BETWEEN DATABASES

Turning now to FIG. 1, there is shown a flow diagram 100, illustrating the prior art of controlling distributed databases with the use of a time stamp. The flow is entered at step 102 when there is a need at step 104 to append database record in database #1 306. (Described below) The database record is appended at step 106.

A time stamp is attached, at step 108 to the record. If there are no additional changes required at step 110 the flow exits at step 112. If there are additional changes at step 110 the flow is reentered at step 106 when the next record is appended, and the flow continues.

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BRIDGE APPLICATION USING A TIME STAMP TAG BETWEEN DATABASES

Turning now to FIG. 2 there is shown a flow diagram 200, which illustrates the bridging application reconciling remote databases, according to prior art. The flow is entered at step 202 when a bridge application is called to reconcile data at step 204, between all the databases. The bridge application selects a first database to be reconciled at step 206. A query is performed on the first database for any records, to be sent to other databases, at step 208, by comparing the time stamps of the records that have not been sent since the time of the last reconciling between databases. The result of the query is sent to the appropriate remote database(s) at step 210. The remote database(s) receives the result of the query at step 212, and append the received data to its database along with the time stamp. In addition the remote database adjusts the time of synchronization from the first database. The bridge application (not shown) then determines if it has completed the synchronization on all of the databases at step 214. If the synchronization is complete the functional flow exits at step 216. If the bridge application determines that there is additional database to be synchronized at step 214, the functional flow diagram is reentered at step 208. This flow is repeated until the last remote database is reconciled under the control of the bridging application and the flow exits at step 216.

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This prior art time stamps method has several shortcomings. The use of time stamps by different organizations in different locations presents a classical coherency problem. Issues such as local time, daylight savings times offsets, the accuracy and diligence of local operators are only some of the problems for a

bridging application. In addition, the opportunity exists for an accidental or malicious operator to adjust the local system clock, which will cause miss synchronization. Distributed databases that are not synchronized can consist of records not sent and reconciled; records sent that have already been sent wasting bandwidth, and perhaps duplicating entries at the sent to database. Accordingly, a need exists for a better method to keep track of the records between remote collaborative databases without the use of the time stamps.

One classical method for time synchronization is for all locations to use GMT (Greenwich Median Time). This is used by the broadcast industry. However the setting and synchronization to yet another location brings still additional problems that must be accounted for. That is, each location must have the correct local time and know the correct offset back to Greenwich England. This solution introduces an additional time offset, which is problematic. Accordingly, a need exists for a method to keep track of the records between remote collaborative databases that are time independent.

Another shortcoming is the frequency and amount of time that is used in synchronizing the databases. It is impractical to send the full database frequently and perform a local compare to check that the distributed databases are synchronized. This method consumes too much network bandwidth and storage. Additionally during the times of reconciling many times the database is "off line". Accordingly, a need exists for a method and system for bridging and transferring only the additions to the database between the different databases, which allows for the timely updates between the distributed databases.

There are prior art solutions that eliminate duplication of records by using timestamps on records and sending only those that have a timestamp greater than that of a certain cached time value. The time value being the timestamp at which the records were last bridged. This has a disadvantage of requiring the bridging

application to store a threshold timestamp after each synchronization and hence entering a maintenance state that can slow down the application, as it has to write to disk from time to time. It also has a potential time synchronization problem, as timestamps are usually not absolute but rather relative. If the systems being bridged were physically in different time zones, the meaning of a timestamp can be confusing to the bridging application and hence erroneous in the goal of eliminating duplicate records. This can happen even in spite of using GMT. During the times of clock changes, such as from daylight savings to standard time, confusion can result. Also, someone can inadvertently or maliciously change the time on the bridging application machine at a certain point of time, which will cause the bridging program to use a wrong threshold timestamp to judge which records to send across. Accordingly, a need exists for a solution that does not rely on time stamps to the bridge records between distributed databases.

15 SUMMARY OF THE INVENTION

Briefly, according to the present invention, disclosed is a method, an apparatus and computer readable medium for automating the synchronization of data that resides on multiple collaborative databases. Described here is a method for exchanging only records that are needed to accomplish the updates, while preserving the individual database schema and security of the different databases.

The present invention uses three fields to describe work accomplished on a given problem. They are a problem identifier, a work identifier and a work description. The first two are numbers. The work identifier being sequential as applied to a given problem identifier. When work is applied to a problem identifier, the work description is entered in text form and the work identifier is incremented. In order to maintain synchronization with the other databases a bridging application will send the newly appended entries. When this has been completed a work entry of a predetermined text string is added, such as "copy sent to system", where the system is the name of the system that was bridged. This marks the point in the database,

above which, all database entries also exist at the bridged database. This removes the time dependency with an event based label while preserving the different database schema.

5 BRIEF DESCRIPTION OF THE DRAWINGS

The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other objects, features, and advantages of the invention will be apparent from the following detailed description taken in conjunction with the  
10 accompanying drawings.

FIG. 1 is a flow diagram describing the prior art of the use of a time-stamp when a database is appended.

FIG. 2 is flow diagram of the prior art of the use of time-stamps by a database  
15 bridge application to reconcile remote databases.

FIG. 3 is a block diagram of an exemplary network, which interconnects informational systems, according to the present invention.

FIG. 4 is block diagram of an exemplary hardware platform with optional components, which is used by the present invention.

FIG. 5 is a block diagram of an exemplary software hierarchy including the  
20 present invention that is executed on the hardware of FIG. 4.

FIG. 6 A is a table of WORK\_HISTORY at a first database server #1 according to the present invention.

FIG. 6 B is a table of WORK\_HISTORY at a second database server # N for  
25 the same work-flow as described in FIG. 6A, according to the present invention.

FIG. 7 is a flow diagram describing the need to append the WORK\_HISTORY in a local database, according to the present invention.

FIG. 8 is a flow diagram of the reconciling of newly appended records with remote database servers by the bridging application, according to the present  
30 invention.

DETAILED DESCRIPTION OF AN EMBODIMENT

It is important to note, that these embodiments are only examples of the many advantageous uses of the innovative teachings herein. In general, statements made in the specification of the present application do not necessarily limit any of the various claimed inventions. Moreover, some statements may apply to some inventive features but not to others. In general, unless otherwise indicated, singular elements may be in the plural and visa versa with no loss of generality.

In the drawing like numerals refer to like parts through several views.

EXAMPLE NETWORK TOPOLOGY

Referring to FIG. 3, shown is a block diagram 300 of a network of computers. The network 302 can be a private Intranet, Internet or other computer network such as a LAN (Local Area Network). The network is typically the Internet and the interconnection software protocol is HTTP (Hyper Text Transfer Protocol). The exact network or its hardware/software protocol is not important to the present invention, and other networks are within the true scope and spirit of the present invention. This exemplary network depicts 1 - N database servers as follows: server #1 104, which hosts database # 1 106, server #N-1 108 which hosts database # N-1 110, and server # N 112 which hosts database #N 114.

The databases #1 through #N represent a plurality of servers which are hosting the same or at least collaborative databases 304, 310, and 314. These servers may be in widely different geographical areas throughout the world. In one embodiment these databases are accessed when information relative to a help desk, or e-commerce, such as commerce over the Internet is desired. In the example above, after the help desk operator accesses a help desk management system through a local database server the results of the help session are appended in the local database. The local record is not synchronized across the other



databases. This results in the other databases becoming unsynchronized. A bridging application is used to transfer the help desk information to the other database servers so this information, known as a trouble ticket can be accessed at the other location. Continuing with the example above, if the end user with the problem goes  
5 on a trip it is advantageous to be able to access the help desk management system from a different geographic location, or even by contacting a different company.

#### Exemplary Computer System

Referring to FIG. 4, there is shown a block diagram 400 of the major  
10 electronic components of an information processing system 400 in accordance with the invention. The electronic components include: a central processing unit (CPU) 402, an Input/Output (I/O) Controller 404, a mouse 432 a keyboard 416, a system power and clock source 406; display driver 408; RAM 410, ROM 412, ASIC (Application Specific Integrated Circuit) 414 and a hard disk drive 418. These are  
15 representative components of a computer. The general operation of a computer comprising these elements is well understood. Network interface 420 provides connection to a computer network such as Ethernet over TCP/IP or other popular protocol network interfaces. Optional components for interfacing to external peripherals include: a Small Computer Systems Interface (SCSI) port 422 for  
20 attaching peripherals; a PCMCIA slot 424; and serial port 426. An optional diskette drive 428 is shown for loading or saving code to removable diskettes 430. The system 400 may be implemented by combination of hardware and software. Moreover, the functionality required for using the invention may be embodied in computer-readable media (such as 3.5 inch diskette 430) to be used in programming  
25 an information-processing apparatus (e.g., a database server) to perform in accordance with the invention.

Given this computer system, the typical Software Operating System and associated supporting applications can be installed which will simulate and display  
30 the results according to the present invention.

EXEMPLARY SOFTWARE HIERARCHY

FIG. 5 is a block diagram 500, illustrating the software hierarchy for the information processing system 400 of FIG. 4 according to the present invention. The BIOS (Basic Input Output System) 502 is a set of low level of computer hardware instructions for communications between an operating system 506, device driver 504 and hardware 400. Device drivers 504 are hardware specific code used to communicate between and operating system 506 and hardware peripherals such as a CD ROM drive or printer. Operating system 506 is the master program that loads after BIOS 502 initializes, that controls and runs the hardware 400. Examples of operating systems include Windows 3.1/95/98/ME/2000/NT, Unix, Macintosh, OS/2, Sun Solaris and equivalents. Applications 508 are software application programs written in C/C++, assembler or other programming languages. Examples of application are a database 510, a bridge application according to the present application 512, a network connectivity application such as is used for the internet 514, and other applications 516 such as word processors and the like.

DISCUSSION OF HARDWARE AND SOFTWARE IMPLEMENTATIONS OPTIONS

The present invention as would be known to one of ordinary skill in the art could be produced in hardware or software, or in a combination of hardware and software. The system, or method, according to the inventive principles as disclosed in connection with the preferred embodiment, may be produced in a single computer system having separate elements or means for performing the individual functions or steps described or claimed or one or more elements or means combining the performance of any of the functions or steps disclosed or claimed, or may be arranged in a distributed computer system, interconnected by any suitable means as would be known by one of ordinary skill in art.

According to the inventive principles as disclosed in connection with the preferred embodiment, the invention and the inventive principles are not limited to

any particular kind of computer system but may be used with any general purpose computer, as would be known to one of ordinary skill in the art, arranged to perform the functions described and the method steps described. The operations of such a computer, as described above, may be according to a computer program contained  
5 on a medium for use in the operation or control of the computer, as would be known to one of ordinary skill in the art. The computer medium, which may be used to hold or contain the computer program product, may be a fixture of the computer such as an embedded memory or may be on a transportable medium such as a disk, as would be known to one of ordinary skill in the art.

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The invention is not limited to any particular computer program or logic or language, or instruction but may be practiced with any such suitable program, logic or language, or instructions as would be known to one of ordinary skill in the art. Without limiting the principles of the disclosed invention any such computing system  
15 can include, inter alia, at least a computer readable medium allowing a computer to read data, instructions, messages or message packets, and other computer readable information from the computer readable medium. The computer readable medium may include non-volatile memory, such as ROM, Flash memory, floppy disk, Disk drive memory, CD-ROM, and other permanent storage. Additionally, a  
20 computer readable medium may include, for example, volatile storage such as RAM, buffers, cache memory, and network circuits.

Furthermore, the computer readable medium may include computer readable information in a transitory state medium such as a network link and/or a network  
25 interface, including a wired network or a wireless network, that allow a computer to read such computer readable information.

SOFTWARE OVERVIEW

The present invention is a distributed computer program that will synchronize collaborative databases. That is databases that are not exact mirror images of each other, and in fact may contain proprietary data that is to be kept confidential and  
5 separate from the other databases. The bridging software must be installed at each database location and be aware of the other locations that are to be synchronized.

BRIDGING APPLICATION DESCRIPTION

The bridging software saves storage space by not storing duplicate records at  
10 different locations, providing for only one synchronized copy of the data at each location. The bridging software also saves bandwidth by not sending data that already exists or has already been sent to the other system. This is achieved by appending an existing record entry in the local database. This event record is a bridging application definition such as "copy in sent-to-system". This entry in the  
15 workflow marks the event of synchronizing with the correct remote databases. At the time of the next synchronization any new entries after the workflow entry "copy in sent-to-system" are synchronized but no "old" workflow entries are sent as they occurred before the "copy in sent-to-system" event record. That is, the bridging application only picks up the workflow records to be synchronized that follow the tag,  
20 "copy in sent-to-system". After sending these records, the present invention immediately inserts another tag. This tag marks the event of the just sent records that now also exist in the remote system.

TIVOLI SERVICE DESK EXAMPLE

25 In one embodiment this method has been advantageously used in bridging two IBM Tivoli Service Desk (TSD) problem management databases. These systems each have a WORK\_HISTORY table that contains descriptions and notes

of the work performed by a customer service representative during the life of a particular user problem.

EXAMPLE OF WORK HISTORY ENTRIES AT TWO DIFFERENT DATABASES

5           Turning now to Fig. 6A, shown is a table 600 for a WORK\_HISTORY for a  
illustrative help desk enterprise in a database #1 106 for PROBLEM\_ID ABC. Each  
database entry has locally based additional entries for each record that are treated  
as separate and confidential by the bridging application. These are not shown.  
Column 602 contains the WORK\_ID for the PROBLEM\_ID ABC. Note that at this  
10   database #1 106 there are numerous entries being made by numerous help desk  
operators. What is shown here are only the entries for PROBLEM\_ID ABC. The  
WORK\_ID has entries that are locally sequential, starting at 1 610 and ending at 8  
626. Column 604 contains the PROBLEM\_ID ABC. In this example this is a problem  
ticket ID for a help desk management system, and identifies a set of symptoms and  
15   the suggested solution given to the end user that has called in with a problem.  
Column 606 contains the WORK\_HISTORY, which is a list of appendable text  
entries. One can read this column and understand the various actions that have  
been taken for the PROBLEM\_ID ABC. Note the lack of any time stamps. Also note  
that the schema of the local database in not changed, that is these record entries  
20   already existed before the implementation of the present invention.

In FIG. 6A, a record 610 contains the first entry, as WORK\_ID 1. The  
WORK\_HISTORY column 606 includes the entry "open ticket for analysis". It would  
also list the problem as described by the end user that has called in. Record 612  
25   contains the second entry, which is WORK\_ID 2. The WORK\_HISTORY has the  
entry "solve ticket ABC". In this example, a help desk operator at database #1 306  
believes that the problem has been solved and lists the problem as closed.

At this point in time the bridging application sends all WORK\_HISTORY entries to the other database such as # N 312 to assure that anyone calling in on this PROBLEM\_ID ABC will have the benefit of the work done to date. Note that only the WORK\_HISTORY, PROBLEM\_ID and WORK\_ID are sent. The other records which may be confidential are not sent, or even accessed by the bridging application. Therefore the entry "copy in system # N" is entered at record 614. This problem however is persistent and the help desk is contacted again with WORK\_ID 4 record 616. The help desk operator, which may not be the original operator can now reopen the problem ticket, read the previous history and suggest additional solutions. This is listed in the WORK\_HISTORY as "reopen ABC for review" 616. This WORK\_ID 4 is then sent to database # N 312 and as such the work history entry "copy in system # N" is listed 618. In the present invention for this problem ticket ABC, it is important to note that only new records are sent. Therefore WORK\_IDs 1 through 3 are not sent. Only the WORK\_ID 4 is sent.

At this point in time the PROBLEM\_ID is considered open and being worked on at database #1 306 and # N 312. An operator at database # N 312 is contacted by the user about problem ticket ABC. In this example the help desk operator may decide that the problem may be with the operating system and not with the hardware at database # 1 so calling the software operating system company is in order. Note that the help desk operator at database # N is working on the problem so the entry "do not bother will work on ABC at # N" is entered at database # N and bridged back to database # 1, at the hardware company. The help desk operator at database # N (the software company) has the benefit of all of the work done up to this point on PROBLEM\_ID ABC. It is also noted that the help desk operator at database # N may have different skills and perspectives relative to the problem. In this embodiment only problem history records are shared between the databases and the other entries in the database records are not shared.

At this point in time the operator at database # 1 lists "solved !" at WORK\_ID 8 record 624. This entry is followed with the entry "copy in system # N" record 626 at WORK\_ID 9, which alerts the operator at database #N that the problem is solved and the problem ticket ABC is closed.

5

This completes the description of the bridging application's actions from the perspective of database #1 306.

Turning now to FIG. 6B, table 650 lists the WORK\_HISTORY for the same PROBLEM\_ID ABC as listed at database # N 314 according to the present invention. At this location there are additional entries to each record from the perspective of a software company. As with database # 1 306, these are not shown but are considered as local and are not transferred by the present invention, a bridging application. Column 630 contains the WORK\_ID for the PROBLEM\_ID ABC at database # N 314. Column 632 contains the PROBLEM\_ID, which in this example is ABC. Column 634 contains the text of the appended work statements for the listed PROBLEM\_ID. At database #N 314 records 636, and 638 were received from database #1 306. This work was done by a help desk operator at database # 1 306. Note that the entries "copy in system # N" records 614 and 618 are not transferred as they are the entries that mark what WORK\_HISTORY records have been transferred and are entered only after the latest entries are entered.

Now at record 640, the help desk operator at database # N has received the WORK\_ID 1 and 2 and thereafter enters WORK\_ID 3 as "Copy in System # 1".

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Now at record 642, the help desk operator at database # N 314 has been contacted, by the end user and the help desk operator has the benefit of the work history done at database # 1. These are WORK\_ID 1 and 2. The help desk operator at database # N 314 makes the entry "reopen ABC for review" record 642. After this

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was entered it was sent by the bridging application to database # 1 306 and is listed in the WORK\_HISTORY as "copy in system # 1" record 644.

5 Now the help desk operator at database # 1 306 is alerted that the operator at database # N 312 is also working on this problem ABC with the message "do bother will work on ABC @ # N", which is WORK\_ID 6 record 646. This message is sent with the WORK\_ID 7 "copy in system # 1" record 648.

10 However, at this point in time the help desk operator at database # 1 106 has discovered the solution to the problem ABC and makes the entry "solved!", at record 624. Finally the bridging application sends this entry 624 to database # N 112 and this is listed as record 650. The database # N sends the message "copy in system # 1" back to database # 1, this being WORK\_ID 9, which acknowledges that the problem ABC has been solved at record 650 by the help desk operator at database  
15 # 1.

This completes the description of the WORK\_HISTORY for PROBLEM\_ID ABC at database # N 112.

20 APPENDING WORK HISTORY IN LOCAL DATABASE

FIG. 7 is a flow diagram 700, which describes entering work completed on a problem at a local database such as # 1 106. The flow is entered 702 when there is a need to describe or append work in the WORK\_HISTORY 606 in the local database at step 704. For this next sequential record WORK\_ID number 602 is  
25 incremented by 1 at step 706. With this in place for a given PROBLEM\_ID 604 the WORK\_HISTORY can be appended at step 708. This entry is simply a statement of the latest work attempted in text form. If the need to append the WORK\_HISTORY is completed at step 710 the flow exits at step 712. In the case there are additional entries to be appended at step 710 a new record is opened, and the flow is



reentered at step 706. Summarized here, for each PROBLEM\_ID the WORK\_ID lists in numerical sequence all work as listed in the WORK\_HISTORY field. If anyone local to this database would like to look at a problem, and the work done on it, the database can be accessed. However, if a different database, in a different location or even hosted by a different company would like to access this information it must be sent or bridged to these databases such as # N-1 310 and # N 314.

DATABASE SYNCHRONIZATION

Turning now to FIG 8, which describes the flow 800 design of the bridging application, according to the present invention. The flow is entered at step 802 when the bridge application needs to reconcile remote the database(s). The bridging application chooses the first remote database # N-1 310 to be reconciled with the local database #1 306 at step 806. A query of the local database # 1 306 for all WORK\_HISTORY entries with WORK\_ID numbers higher in sequence than the record which contains the entry "copy in sent-to-system X" (X being N-1 for this first step) entry in WORK\_HISTORY field for the selected remote database at step 808 is made. As a result of this query a list is assembled and is sent to the selected remote database # N-1 310 at step 810.

After the new list of WORK\_HISTORY is sent at step 810, the local database # 1 306 appends the entry "copy in system X" in the WORK\_HISTORY field against the PROBLEM\_ID that was sent and adds the next number in sequence in the WORK\_ID field for this record at step 812. This entry acts as a time independent statement of which records have been sent to the remote database # N-1 310. If there are no additional database systems that need to be reconciled at step 814 the flow exists at step 816. If there are additional remote databases that need reconciling, such as database # N 314, the number of system X is changed to N at step 818 and the flow is reentered at step 808.

It is noted that the bridging application is also installed at the remote databases and they must reconcile their WORK\_HISTORY records with the other databases.

- 5 In an alternative embodiment after synchronization records are transferred any work lists control records that are less than the WORK\_ID sequence listing the just synchronized entry are deleted at the different databases for the given Problem\_ID.

Non-Limiting Examples

- 10 Although a specific embodiment of the invention has been disclosed. It will be understood by those having skill in the art that changes can be made to this specific embodiment without departing from the spirit and scope of the invention. The scope of the invention is not to be restricted, therefore, to the specific embodiment, and it is intended that the appended claims cover any and all such applications, modifications, and embodiments within the scope of the present invention.
- 15

The present invention provides for time independent synchronization of database records between remote servers that may choose to maintain different schema and even have parts of the database be considered confidential.

20

What is claimed is: